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Indian Standard

SPECIFICATION FOR ELECTRICAL GRADE CASTOR OIL FOR USE AS CAPACITOR IMPREGNANT

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Indian Standard

SPECIFICATION FOR ELECTRICAL GRADE CASTOR OIL FOR USE AS CAPACITOR IMPREGNANT

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Indian Standard

SPECIFICATION FOR ELECTRICAL GRADE CASTOR OIL FOR USE AS CAPACITOR IMPREGNANT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 1 October 1981, after the draft finalized by the Liquid and Gaseous Dielectrics Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard is intended for the electrical grade castor oil, used in medium voltage power capacitors and high voltage energy storage capacitors. Castor oil complying with the requirements of this standard may also be used in other types of capacitors the suitability of which is being examined at present. Since this grade of castor oil has the best attainable electrical properties, it may find use as a plasticizer for electrical grade synthetic resins, like vinyl resins.

0.3 Requirements of castor oil other than electric grade have been laid down in IS : 435-1973*.

0.4 While preparing this standard assistance has been derived from ASTM D 1903-1963 'Coefficient of thermal expansion of electrical insulating liquids of petroleum origin and askarels', issued by the American Society for Testing and Materials.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements and methods of test for electrical grade castor oil used in medium voltage power capacitors and high voltage energy storage capacitors (*see also* **0.2**)

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*Specification for castor oil.

†Rules for rounding off numerical values (*revised*).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Specific Gravity — The ratio of the weight in air of a given volume of the oil at 30°C to the weight in air of an equal volume of water at 30°C.

2.2 Viscosity

2.2.1 *Dynamic Viscosity* — Dynamic viscosity of a fluid is the tangential force on a unit area either of two parallel planes at unit distance apart when the space between the plane is filled with fluid and one of the planes moves relatively to the other with unit velocity in its own plane.

2.2.2 *Kinematic Viscosity* — Kinematic viscosity of a fluid is equal to the quotient of dynamic viscosity and density.

2.3 Refractive Index — The ratio of the velocity of light in a vacuum to the velocity of light in oil; more generally it expressed the ratio of the sine of the angle of incidences of the sine of angle of refraction, when a ray of light of known wavelength (usually 589·9 mμ, the mean of the *D* lines of sodium) passes from air into oil.

2.4 Coefficient of Thermal Expansion — The coefficient of thermal expansion of liquid is the increase in volume per degree change in temperature. It is commonly stated as the average coefficient over a given temperature range.

2.5 Pour Point — The lowest temperature expressed as a multiple of 3°C at which the oil is observed to flow when cooled and examined under prescribed conditions.

2.6 Flash Point — The temperature at which the oil gives off so much vapour that this vapour, when mixed with air, forms as ignitable mixture and gives a momentary flash on application of a small pilot flame under the prescribed conditions of test.

2.7 Burn Point — The temperature at which the oil gives off so much vapour that this vapour when mixed with air forms an ignitable mixture and burns continuously on application of a small pilot flame under prescribed conditions.

2.8 Total Volatile Matter — The total volatile material is the matter contained in the oil, which is volatile under prescribed conditions.

2.9 Acid Value — The number of milligrams of potassium hydroxide required to neutralize the free acid present in one gram of oil under prescribed conditions.

2.10 Saponification Value — The number of milligrams of potassium hydroxide required to saponify completely one gram of oil under the conditions of prescribed test.

2.11 Iodine Value (Wij's) — The number of grams of iodine absorbed per 100 gram of the oil when determined by using Wij's solution.

2.12 Acetyl Value — The number of milligrams of potassium hydroxide required to neutralize the acetic acid liberated by hydrolysis of one gram of the acetylated castor oil.

2.12.1 Acetyl value of the oil is a measure of hydroxyl content of material.

2.13 Peroxide Value — The peroxide value is a measure of the peroxides contained in a sample of oil expressed as milliequivalent of peroxide per 1 000 g of material.

2.14 Unsaponifiable Matter — The fraction of substances in oils which is not saponified by caustic alkali but is soluble in ordinary fat solvents.

2.14.1 It includes higher aliphatic alcohols, sterols, pigment hydrocarbons and resinous matter.

2.15 Resistivity — The resistivity (specific resistance) in ohm-centimetres of a liquid, is the ratio of the dc potential gradient in volts per centimetre parallelling the current flow within the specimen, to the current density in amperes per square centimetre at a given instant of time under prescribed conditions. This is numerically equal to the resistance between opposite faces of a centimetre cube of the liquid.

2.16 Permittivity — The permittivity of oil is the ratio of capacitance C_p of a given configuration of electrodes with the material as dielectric to capacitance C_v of the same electrode with air as dielectric.

2.17 Dissipation Factor — The dissipation factor of the material is the ratio of conductance G of a capacitor in which the material is the dielectric to its susceptance B: or the ratio of parallel reactance X_p to its parallel resistance R_p as illustrated in Fig. 1. It is also the tangent of the loss angle (Tan δ) and cotangent of phase angle (cot θ) as illustrated in the vector diagram in Fig. 1.

2.18 Repeatability — A quantitative measure of the variability associated with a single operator in a given laboratory obtaining successive repeat result on the same apparatus. It is defined as that difference between two such single results that would only be exceeded in the long run in one case in twenty in the normal and current operation of the test method.

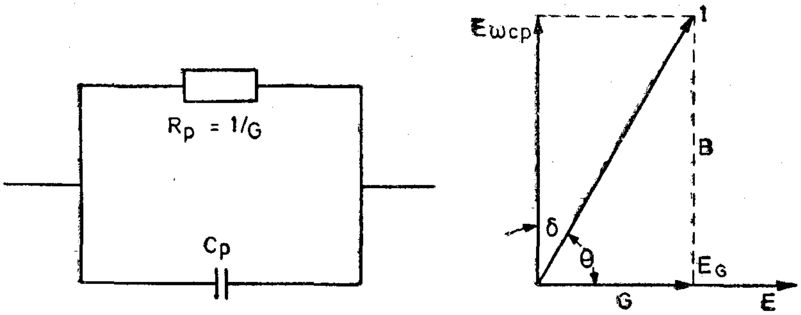

FIG. 1 EQUIVALENT PARALLEL CIRCUIT AND VECTOR DIAGRAM

2.19 Reproductability — A quantitative measure of variability associated with operators woking in different laboratories each obtaining single result on identical test material. It is defined as that difference between two such single and independent test results that would be exceeded in the long run in only one case in twenty in the normal and correct operation of test method.

3. REQUIREMENTS

3.1 General — The oil shall be the genuine cold drawn, refined and properly processed product of castor seed (*Ricinus Communis* Linn). It shall be free from admixtures with other oils or substances and also free from sediment and suspended matter. The oil shall be practically odourless. However, a mild odour characteristic of castor oils shall be acceptable.

3.2 The characteristics of the oil when it is sampled (*see* **5**) and tested, in accordance with the methods referred to shall comply with the requirements laid down in col 4 of Table 1.

TABLE 1 OIL CHARACTERISTICS
(*Clauses* 3.2 and 5.1)

SL No. (1)	PROPERTY (2)	VALUE (3)	TEST METHOD, IN ACCORDANCE WITH (4)
i)	Appearance	Clear, light yellow viscous liquid, free from suspended matter	A representative sample of the oil shall be examined in a 100 mm thick layer at ambient temperature
ii)	Specific gravity :		
	a) at 30°C/30°C	0·954-0·960	Cl **11** of
	b) at 90°C/30°C	0·920-0·926	IS : 548 (Part I)-1964*

*Methods of sampling and test for oils and fats : Part I Sampling, physical and chemical tests (*revised*).

(*Continued*)

TABLE 1 OIL CHARACTERISTICS — *Contd*

Sl No. (1)	Property (2)	Value (3)	Test Method, in Accordance with (4)
iii)	Kinematic viscocity, cSt		IS : 1448 [P : 25]-1976*
	a) At 27°C	510-550	
	b) At 90°C	Under consideration	
iv)	Refractive index at 27°C	1·477 0-1·481 0	Cl 10 of IS : 548 (Part I)-1964†
v)	Coefficient of thermal, per deg C expansion (volumetric)	0·000 70	Appendix A
vi)	Pour point, °C, *Max*	—15	IS : 1448 [P : 10]-1970‡
vii)	Flash point, °C, *Min*	275	IS : 1448 [P : 21]-1970§
viii)	Burn point, °C, *Min*	290	Appendix B
ix)	Total volatile matter, percent, *Max*	0·1	Cl 5 of IS : 548 (Part I)-1964†
x)	Acid value mg of KOH per gm of oil, *Max*	0·02	Cl 7 of IS : 548 (Part I)-1964†
xi)	Saponification value, mg of KOH per g of oil	177-185	Cl 15 of IS : 548 (Part I)-1964†
xii)	Iodine value, g of I_2 absorbed in 100 g of oil	82-90	Cl 14 of IS : 548 (Part I)-1964†
xiii)	Acetyl value, mg of KOH per g of acetylated oil, *Min*	143	Cl 16 of IS : 548 (Part I)-1964†
xiv)	Peroxide value, milliequivalent per thousand gms, *Max*	10	Cl 21 of IS : 548 (Part I)-1964†
xv)	Unsaponifiable matter, percent, *Max*	0·8	Cl 8 of IS : 548 (Part I)-1964†
xvi)	Resistivity, ohm-cm, *Min* (500 V dc 1 min) :		
	a) At 20°C	20×10^{12}	IS : 6103-1971‖
	b) At 90°C	1×10^{12}	

*Methods of test for petroleum and its products : P : 25 Kinematic and dynamic viscosity (*first revision*).

†Methods of sampling and test for oils and fats : Part I Sampling, physical and chemical tests (*revised*).

‡Methods of test for petroleum and its products : P : 10 Cloud point and pour point (*first revision*).

§Methods of test for petroleum and its products : P : 21 Flash point (closed) by Pensky-Martens apparatus (*first revision*).

‖Methods of test for specific resistance (resistivity) of electrical insulating liquids.

(*Continued*)

TABLE 1 OIL CHARACTERISTICS — *Contd*

Sl No. (1)	Property (2)	Value (3)	Test Method, in Accordance with (4)
xvii)	Dielectric constant, *Min* :		IS : 6262-1971*
	a) At 27°C	4·0	
	b) At 90°C	4.0	
xviii)	Dielectric dissipation factor (tanδ) at 50 Hz, *Max* :		IS : 6262-1971*
	a) At 27°C	0·000 7	
	b) At 90°C	0·002 0	
xix)	Breakdown voltage, kV, *Min*	50	IS : 6792-1972†
xx)	Ash value, percent by weight, Max	0·1	Appendix C
xxi)	Optical rotation at 25°C, degree, *Max*	3·5	Appendix C of IS : 435-1973‡
xxii)	Water content, ppm, *Max*	50	IS : 2362-1973§
xxiii)	Ageing test	Under consideration	

*Methods of test for power factor and dielectric constant of electrical insulating liquids.

†Method for determination of electric strength of insulating oils.

‡Specification for castor oil (*second revision*).

§Determination of water by the Karl Fischer method (*first revision*).

4. SAMPLING

4.1 Sampling of the oil shall be done in accordance with IS : 6855-1973*

5. TEST METHODS

5.1 The tests shall be carried out in accordance with the test methods referred in Table 1.

5.1.1 *Quality of Reagents* — Unless specified otherwise, pure chemicals and distilled water (*see* IS : 1070-1970†) shall be employed in tests.

Note — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the test results.

6. PACKING AND MARKING

6.1 Packing — After the processing of the castor oil, the electrical grade castor oil shall be stored in steel drums of 5, 20 and 200 litres capacity according to the requirement. The drums shall be effectively sealed to exclude moisture.

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*Method of sampling for liquid dielectrics.

†Specification for water for general laboratory use (*second revision*).

6.2 Marking

6.2.1 The drums shall be indelibly marked with the following:

a) Manufacturer's name or trade-mark, if any;
b) Quantity in litres;
c) Name of the material;
d) Country of manufacture; and
e) Identification in code or otherwise to enable the date and lot of manufacture to be traced back to the factory records.

6.2.2 The containers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of ISI Certification Mark may be granted to manufacturers or processors may be obtained from the Indian Standards Institution.

APPENDIX A

[*Table* 1, *Item* (v)]

DETERMINATION OF COEFFICIENT OF THERMAL EXPANSION OF OIL

A-1. APPARATUS

A-1.1 Specific gravity bottle, 50 ml.

A-1.2 Water bath capable of maintaining the test temperature constant to within ± 0·2°C.

A-1.3 Thermometer — Any convenient thermometer of a suitable range with 0·2°C sub-division. The thermometer may be checked and calibrated against a standard thermometer.

A-2. PROCEDURE

A-2.1 Determine the specific gravity of the oil at two temperatures (preferably 30°C and 90°C) by method of test for specific gravity [*see* IS : 548 (Part I)-1964*]. The difference in observed specific gravities at two temperatures dividend by the product of specific gravity at lower temperature and the difference in two temperatures may be used as the average coefficient of expansion for observed temperature range.

A-3. CALCULATIONS

A-3.1 The specific gravity is determined at these temperatures and the coefficient of thermal expansion calculated as follows:

$$\text{Coefficient of thermal expansion} = \frac{S - S_1}{S\,(T_1 - T)}$$

where

S = specific gravity at the lower temperature T, and
S_1= specific gravity at the higher temperature T_1.

A-4. SIGNIFICANCE

A-4.1 A knowledge of coefficient of thermal expansion of the oil is essential to compute the required size of a container to accommodate a volume of oil over the full temperature range.

APPENDIX B

[*Table* 1, *Item* (viii)]

DETERMINATION OF BURN POINT

B-1. First flash point is determined according to IS : 1448 [P : 21]-1970†. The heating is continued to the point at which the vapours continue to burn in the presence of pilot flame. The minimum temperature at which the vapour continues to burn is taken as burn point.

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*Methods of sampling and test for oils and fats : Part I Sampling, physical and chemical tests (*revised*).

†Methods of test for petroleum and its products : P : 21 Flash point (closed) by Pensky Martens apparatus (*first revision*).

APPENDIX C

[*Table* 1, *Item* (xx)]

DETERMINATION OF ASH

C-1. PROCEDURE

C-1.1 Weigh a clean and previously ignited porcelain crucible or dish, introduce 10 to 25 ml of the material and weigh again. Heat the material and ignite it by playing the flame of burner on the surface of the material and allow it to burn quietly until most of the material is burnt away. Transfer the crucible or dish to a muffle furnace or heat it over a burner at or below dull red heat until all carbonaceous matter is consumed. Cool the crucible or dish and weigh. Repeat heating cooling and weighing till the weight is constant.

C-2. CALCULATION

C-2.1 Calculate the weight of the ash and express the result as percentage of the weight of the material taken for the test.